invented the new numbers $a + bi$ and annexed them to complete our field of number; rather let us say that, as in the former case of the straight line for scalars, we have found, ready to hand, a field of quantity of the desired kind, namely, one[1] in which the roots of a quadratic are always possible.

The mode of performing geometrically the fundamental operations of algebra with complex quantities; the mode in which the idea of absolute magnitude is attached to them; the construction of the roots of unity with their introduction to the many-valued function; and later their application to the power series; can hardly fail to interest and stimulate the student.[2]

Finally we observe that, at this point, the student will have an intelligent appreciation of the meaning of the fact, which may now be stated (without proof, for which he is, of course, not yet prepared), that every equation of the nth degree has n roots; no new anomaly appearing in the solution of those of higher degree, although new incommensurables do occur; thus the system of complex quantities is a complete set reproducing itself through all the operations of algebra, direct and indirect.

II. On the Teaching of Logarithms.

By R. B. McClenon, Grinnell College.

How should the subject of logarithms be presented to the beginner? The usual method has been, to start with the laws of exponents, define logarithms as powers of the base, and thus infer the fundamental laws of operation. This approach, however, is extremely likely to prove confusing to the student, because it does not bring out clearly enough the functional relation involved; and this disadvantage is accentuated by the impossibility of giving a satisfactory discussion of the meaning of an irrational exponent until a later stage of the mathematics course.

Two other methods have been proposed as a substitute for this one. One suggestion is, to use the historical approach, as employed by Napier in his invention of logarithms.[3] This would begin with the fundamental idea of the relation between an arithmetic and a geometric progression, the notion of "base" being at first entirely ignored. With the help of graphical methods, and an abundance of concrete problems chosen from physics, economics, and finance, it is said to be possible to bring out clearly and vividly the relation between the exponential and logarithmic functions. The other suggestion is, to abandon frankly all attempt to *explain* logarithms at the outset, but rather to focus the attention upon the actual use of logarithmic tables, until the mechanical rules for computa-

[1] A former student of Kronecker once told me that Kronecker would never admit the existence of a complex quantity. He said "there was not any complex variable $x + iy$. There were two variables, x and y." Whatever we say to this verbal contention, we shall continue to say that it takes two quantities (*i. e.*, scalars) to determine the position of a point in a given plane.

[2] In this connection the writer may refer to a construction of the roots of the quadratic with complex coefficients given by him to the New York Mathematical Society in 1893 and, in abstract, in the *Bulletin*, Vol. 2, p. 171.

[3] See, for example, Cajori, "History of the Exponential and Logarithmic Concepts," Am. Math. Monthly, Vol. 20 (1913), pp. 5–14.

tion have become thoroughly familiar. Then, it is urged, the student will find it easier to appreciate the theoretical discussion which comes later, as this will merely take the line of explaining the reasons for facts of whose truth he is already convinced.

Both of these suggestions seem worthy of being tried out, and they may very likely have been already. If so, it is to be wished that some testimony as to the results might be presented in this department of the MONTHLY; as well as any other suggestions that have been found helpful in the teaching of this subject.

The last plan mentioned above, the postponement of the theoretical part of the work until the practical use of logarithms has been mastered, would prove most satisfactory if this practical part of the work could be introduced into the secondary school mathematics course, as would certainly seem desirable on many grounds. When this is done, the problem of the college teacher will be much simplified, and, what is of course of incomparably greater importance, the secondary school student will have the added knowledge and power that come from acquaintance with the practical use of so valuable a mathematical tool.

RECENT PUBLICATIONS.

REVIEWS.

HINDU SCIENCE.

Hindu Achievements in Exact Science, A Study in the History of Scientific Development. By B. K. SARKAR. Longmans, New York, 1918. 13 + 82 pp. Price, $1.00.

"The Astronomical Observatories of Jai Singh." By G. R. KAYE. *Archeological Survey of India,* New Imperial Series, Vol. 40. Calcutta, 1918, 8 + 154 pages + 26 plates and frontispiece photograph of Jai Singh. Price 15 rupees.

These two works are illustrative of two well-defined tendencies which have been existent for fifty years or more, in the discussion of Hindu science. The work of Sarkar is that of the enthusiast for all things Hindu; here we have the acceptance of practically all claims for the Hindu origin of different scientific ideas, with the general denial of foreign influence. In the work of Kaye we have the insistence upon the absolute dominance of foreign ideas in Hindu science, with the practical denial of any indigenous contribution.

Unfortunately *Hindu Achievements* is written by one who does not treat historical material critically; thus we have works of real value and works of no value cited as authorities, with a preponderance in favor of obsolete and even worthless works relating in one way and another to Hindu science. On the other hand Mr. Kaye is familiar with the modern authorities in the field of the history of science. This work of Jai Singh is a work of real merit but even it exhibits the tendency to depreciate the value of Hindu contributions which has characterized much of Mr. Kaye's work.